INFLUENCE OF FIELD-APPLIED CHEMICAL ADDITIVE ON DUST LEVELS IN COTTON

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ABSTRACT

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Application of a mineral oil to seed cotton during harvest reduced respirable dust in an instrumented carding room. The reduction, however, was not great enough to qualify field application of oils as a single solution to reduce respirable dust to target levels.

KEYWORDS: Harvesting, ginning, spinning, respirable dust, quality, additives, byssinosis, trash.

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By Lyle M. Carter, Henry H. Perkins, Jr., and Ivan W. Kirk[1]

INTRODUCTION

The respirable fraction of the dust generated when cotton is ginned or processed has been linked to byssinosis, a respiratory disease experienced by some cotton workers. The Occupational Safety and Health Administration has established a standard that limits worker exposure to cotton dust in yarn manufacturing areas to an 8-hour time-weighted average level of 200 $\mu g/m^3$ of air. Tests have shown that additives applied to cotton at the gin and in the opening picking line significantly reduce the dust levels generated in carding.[2 3 4]

If the additive were applied to cotton in the harvesting operation, the effectiveness of the additive could possibly be enhanced because of more uniform distribution of additive. A test was planned in which an additive, which had proved effective in gin and mill tests, was applied to cotton in the harvesting operation. Specifically, the objectives of the study were to determine the feasibility of applying a chemical additive to seed cotton during harvesting to control dust levels during ginning and processing and to determine the additive's effect on ginning quality, fiber properties, and processing quality.

GENERAL PROCEDURES

Applying the Additive

The additive, Texspray[5], was applied as an atomized spray to the seed cotton during harvest. The oil fog was introduced into the seed cotton transport system of a spindle-type cotton harvester in the chamber between the doffer and the suction tube leading to the fan. The location was chosen to allow maximum exposure to seed cotton and to treat the entire air volume with the atomized additive. Three Spraying Systems[6] pneumatic atomizing-type J nozzles (with internal 2,050 fluid nozzles and 67,147 air nozzles) were used with two nozzles placed inside the front drum access door and one in the rear to approximate the ratio of seed cotton harvested by the front and rear drums. The degree of atomization was adjusted by regulating the air pressure. A stable oil fog with negligible drip was produced with 35 pounds per square inch of air.

Application rate was controlled by variable area tube flowmeters equipped with metering valves. Direct metering of the oil was attempt-

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[2]Cocke, J. B., and R. A. Wesley. Controlling cotton dust in textile mills by applying additives at the gin. Transactions of the American Society of Agricultural Engineers 22(2): 418-420, 424. 1979.

[3]Cocke, J. B., H. H. Perkins, Jr., and C. K. Bragg. Use of additives to reduce cotton dust levels. America's Textiles Reporter/Bulletin AT-6(3): 43-46. 1977.

[4]Cocke, J. B., and R. A. Wesley. Influence of the gin-applied cotton additive on dust levels, processing performance, and yarn quality. U.S. Department of Agriculture, Marketing Research Report No. 1096. 1978.

[5]Registered trademark of Texaco, Inc.

[6]Registered trademark of Spraying Systems Co.

ed but discarded after a first field trial due to changes in the oil viscosity and flow rate with the wide variation in temperature experienced during the harvest period. Special equipment was built consisting of two 4-inch-diameter Plexiglas tubes, 3 feet long, mounted vertically with suitable plumbing. Initially, the tubes were filled with water through valves located at the bottom of each tube. Valves were then shifted, and oil was introduced to the top of the column, displacing water, until the tubes were approximately 80 percent filled with oil. During application, water was metered separately into the bottom of each vertical tube with variable area flowmeters with metering valves. The oil was delivered from the top of the tubes to the liquid port of the atomizing nozzles. Since the viscosity of water vaires much less over a given temperature range than oil, this system allowed reasonable accuracy in additive delivery rate.

The flow delivery rate of the additive was judged by measuring the seed cotton harvest rate of the adjacent row. Using this harvest rate and the intended additive application rate for that particular lot, the flow rate was calculated for the front and rear harvester drums and adjusted using the variable rate flowmeters. The amount of oil on the lint at various stages of processing was determined by extraction with Freon TF[7] solvent.[8]

Harvesting

The lots were harvested between October 26 and 28, 1976. The weather was clear, warm, and dry throughout the harvest period. Harvesting was restricted to the hours between 11:00 a.m. and 4:00 p.m. to minimize the variation in seed cotton moisture. The harvester used was an International Harvester model 320 H single-row harvester in excellent mechanical condition with normal adjustments and operation.

The field selected for the study was located on the W. B. Camp and Sons Farm. The field was chosen for proximity to the USDA Cotton Research Station, Shafter, Calif., and to minimize research costs. The field had been planted to an experimental strain, S918, for yield evaluation. (S918 is a 50-percent component of a mechanical mixture of two strains that define the variety Acala SJ-2.) The degree of defoliation at harvesttime was moderate to poor, ranging from 30 to 80 percent estimated defoliation. Each harvested lot was placed in a separate container at harvesttime, and the containers were moved for temporary storage to the U.S. Cotton Research Station.

Ginning

The cotton was ginned on the small-sample gin located on the USDA Cotton Research Station between November 1 and 3, 1976. The gin consisted of: bulk extractor, 6-cylinder incline cleaner, 7-cylinder impact cleaner, cleaner-feeder, 30-saw gin stand with 12-inch diameter saws, and lint cleaner with no provision for seed cotton drying. All machines had been modified by reducing the width to match the flow rate of the 30-saw gin stand. The lots were ginned in the order of increasing oil content to minimize the effect of gin machinery contamination. The ginning rate averaged 5.6 pounds of lint per minute.

Estimation of dust levels in the gin were made near the gin stand (area 1) and at a point near the lint cleaner and bale press (area 3). Sampling instrumentation at each location consisted of a vertical elutriator, a 7.4 L/min area sampler, a 1.5 L/min area sampler, and a high volume sampler. In addition, the gin stand operator wore a 1.5 L/min personal sampler during the time each treatment lot was processed as he worked in area 1. Dust concentrations, in micrograms per standard cubic meter of air, were calculated from the weight of dust collected, and the total airflow was corrected to standard conditions.

Processing and Testing

Mill-Processing Organization

The cotton treatment lots were processed through spinning at the USDA Cotton Quality Research Station, Clemson, S.C. Lots were ran-

[7]Registered trademark of I. E. Dupont de Nemours, Inc.

[8]Perkins, Henry H., Jr., and Bragg, C. K. Effects of oil contamination of cotton quality: methods of analysis and characterization of contaminants. Textile Research Journal 47(4):271-266. 1977.

domized among oil content levels. The following processing organization was used:

Picker	No. 12 cleaner, 14-oz lap.
Card	50-grain sliver, 20 lb/hr.
Breaker drawing	8 ends up, 53-grain sliver.
Finisher drawing	8 ends up, 55-grain sliver.
Roving	1.0 hank, 1.30 twist multiplier.
Ring spinning	40s (14.8 tex) yarn, 3.54 twist multiplier, 13,000-r/min spindle speed, 7056-spindle-hr test.
Open-end spinning	12s (49.2 tex) yarn, 5.0 twist multiplier, 46,000 r/min rotor speed.

Dust Measurements

All lots were processed through a cardroom for dust measurements under standard test conditions as follows: Temperature, 75°F; relative humidity, 55 percent; airflow rate, 550 ft^3/min; and changes of room air, 11.5 times per hour. The card and cardroom contained no other dust control devices. Dust samples were collected with the personal sampler, used as a stationary sampler, and with the vertical elutriator sampler. Dust levels were determined by published methods.[9,10]

Fiber and Yarn Tests

Fibrograph-length, Pressley-strength, and micronaire-fineness measurements were made on ginned lint and on finisher-drawing sliver. One measurement of skein strength and yarn size was made on each of 40 bobbins from ring spinning and two measurements on each of 20 tubes from open-end spinning for each spinning lot. Ten single-strand strength measurements were made on each of 40 bobbins of ring yarn and 20 measurements on each of 20 tubes of open-end yarn for each spinning lot. For each type of yarn, yarn grade was determined from three yarn boards per spinning lot by three techniques. Sixteen bobbins were tested for yarn evenness and imperfections for each yarn. The sensitivity of the tester was set at 30 percent for thin places and at setting No. 4 for thick places and neps. Yarn from each bobbin was tested at 25 yd/min for 5 min (2,000 yd/lot). The number of imperfections per 1,000 yd was also recorded.

Test Design and Analysis of Data

Twelve lots of seed cotton were harvested at random from locations in the field. Two lots were harvested without oil. For the remaining 10 lots, the intent was to vary the oil content as uniformly as possible from 0.1 to 0.5 percent. The design was chosen to allow regression analysis for two important reasons. First, the main objective of the test was to determine the effect of additive level on the quality measure. Although 3 or 4 points (as would be available from a randomized block design of the same total number of lots) can define a regression coefficient (b_1), the confidence is improved with 12 points. Second, preliminary trials indicated that the amount of oil in a lot would vary more than arbitrary treatment boundaries. This can be partially explained by the relatively small difference in ratios desired and unavoidable errors in estimating harvest rate and oil transfer rate within the air delivery system.

Standard regression analysis techniques were used. The oil content in the finished drawing sliver was selected as the independent variable for most analyses. The correlation coefficient (R) was used to determine significance of regression. The confidence interval for the b_1 was computed when R was significant at 95-percent probability or greater.

RESULTS

Oil Levels

The amount of oil in the finished drawing sliver ranged from zero for the two check lots to 0.4 percent for the highest lot (table 1).[11] The variability among subsamples decreased with the number of processing steps. Although the

[9]Cocke, Joseph B., Hatcher, J. D., and Smith D. L. Experimental cardroom for studying dust generation by cotton. America's Textiles Reporter/Bulletin AT-4(5):16-21. 1975.

[10]Perkins, Henry H., Jr. Handling and weighing polyvinyl chloride filters in dust measurements. Textile Research Journal 45(1):25-27. 1975.

[11]All tables appear in the appendix, beginning on p. 6.

amount of oil applied was an excellent estimate of the final content, sampling at early stages in processing gave poor estimates (table 2).

Dust Levels

The presence of oil in the lint reduced the respirable dust in the cardroom. The probability that no relationship exists was less than 5 percent for the vertical elutriator data and less than 1 percent for the personal sampler; however, the reduction in dust was small.

With a probability of 95 percent, the range of reduction in respirable dust for each added 0.1 percent of oil was between 50 and 301 $\mu g/m^3$ as measured by the vertical elutriator in the cardroom. The b_1 was -175 $\mu g/m^3$ per 0.1-percent oil (table 3). The comparable values for the personal sampler were between 85 and 354 with a b_1 of -220 $\mu g/m^3$ per 0.1-percent oil. The samples obtained in the gin show no strong relationship; however, there was a trend (probability = 90 percent) for lower levels of respirable dust with increasing rates of oil near the lint cleaner and bale press (table 3).

Estimates of dust levels obtained in the gin could not be correlated with respirable dust in the cardroom (table 4). A possible exception was the relationship between the personal sampler worn by the ginner and the vertical elutriator in the cardroom (table 4). The personal sampler was a good indicator of the dust samplers within the gin with the exception of the vertical elutriator sampler located near the lint cleaner. There was a high degree of correlation between the personal sampler and vertical elutriator located near the gin stand. These data suggest that the air volume within the gin sampled by the vertical elutriator is more restricted than that sampled by the other samplers.

Seed Cotton Moisture and Trash

Varying levels of oil in the seed cotton had no effect on seed, lint, or seed cotton moisture (table 5). The amount of fine trash in the wagon seed cotton sample, obtained prior to ginning, increased proportionately with the amount of oil. This relationship was reflected in the total wagon trash samples. (See table 5.) With a probability of 95 percent, the range of the increase of fine trash for each added 0.1 percent of oil was between 0.02 and 0.68 percent. The $b1$ was 0.35 percent per 0.1-percent oil. The relationship was reduced to a trend after seed cotton cleaning (table 5).

Fiber Quality

Several measurements of fiber quality may be affected by varying oil levels. Lint samples obtained at the gin lint slide showed a reduction in fiber fineness with increasing rates of oil. With a probability of 95 percent, the range of the decrease of fiber fineness with each 0.1 percent of oil was between 0.018 and 0.110 micronaire. The calculated b_1 was -0.064 micronaire. This relationship was not apparent for samples obtained at the first lint cleaner or from the bale but was found as a trend with samples taken at the drawing frame (table 6).

Fiber uniformity appeared to be improved by increasing levels of textile oil for the samples taken from the bale. The range of increase at the 95-percent probability level was between 0.019 and 0.420 percent per 0.1-percent oil. The relationship could not be verified by samples obtained at the drawing frame (table 6).

The lint trash content from samples obtained at the gin lint slide, as determined with a Shirley Analyzer, increased with increasing levels of oil. This observation partially verifies the observation of increased fine trash in the wagon seed cotton sample. The range of the increase at the probability level of 95 percent was 0.003 to 0.785 percent per 0.1-percent oil. The b_1 was 0.394 percent per 0.1-percent oil. The lint trash relationship was not apparent in other samples (table 7).

The color of the lint was adversely affected by increasing levels of oil. The estimate of the reduction in the lint classification color index was 2.17 percent per 0.1-percent oil (table 7). The relationship is mirrored in the composite lint classification. The relationship is related to change in the lint reflectance as measured on the colorimeter with lint samples from all sources. Cleaning the lint with a Shirley Analyzer did not appreciably alter this relationship (table 8). The reduction in the reflectance (R_d)

with 0.1-percent oil averaged 1.41 for the uncleaned samples and 0.98 for the cleaned samples (table 8). The yellowness (+*b*) was not affected by oil.

The fiber length distribution of ginned lint was not affected by varying levels of oil; however, the coefficient of variability of fiber length distribution of lint in the drawing sliver increased with increasing rates of oil. This increase was apparently caused by an increase in fibers less than one-half inch in length (table 9). With a probability of 95 percent, the increase in fibers less than one-half inch long for each 0.1-percent oil was between 0.006 and 0.540 percent. The calculated b_1 was 0.273 percent per 0.1-percent oil.

Processing Performance

The amount of card waste increased slightly with increasing content of oil. The calculated b_1 was 0.66 percent per 0.1-percent oil with 95-percent confidence limits of 0.016 to 0.149. A reduction in the number of thick places per 1,000 yards of yarn was observed for increasing content of oil. The calculated b_1 was -67.8 thick places per 0.1-percent oil (table 10). All other quantitative processing data showed no relation to oil content.

Severe buildup on the first and second drafting rolls of the drawing frame occurred during processing of certain lots. The rolls were cleaned between lots. Although no quantitative data were obtained, the degree of buildup appeared to be related to the amount of textile oil in the lint. The problem was also observed on the roving frames.

Open-End Spinning

The only measurement affected by increasing levels of oil on open-end spinning was single-strand elongation. The b_1 was -0.086 percent per 0.1-percent oil with 95-percent confidence limits of -0.008 to -0.163 (table 11).

SUMMARY AND CONCLUSIONS

Application of a mineral oil to seed cotton during harvest reduced respirable dust in an instrumented carding room. The test was conducted at the USDA Cotton Research Station, Shafter, Calif., in 1976; the lint was processed at the USDA Cotton Quality Research Station, Clemson, S.C. The additive Texspray, was applied as a fog into the harvester seed cotton air transport system at varying rates, resulting in oil contents between zero and 0.4 percent in the finished drawing sliver lint. The reduction in respirable dust was directly proportional to the oil content in the lint and was estimated by regression analysis to be 175 $\mu g/m^3$ per 0.1 percent of oil. The reduction, however, was not great enough to qualify field application of oils as a single solution to reduce respirable dust to target levels. At the maximum level, 0.4 percent, the respirable dust was reduced from 2400 to 1700 $\mu g/m^3$, which is a 29-percent reduction.

One cotton quality characteristic was severely affected with increasing rates of field-applied oil. The lint reflectance (R_d) was reduced by 5.52 percent at the maximum application rate, resulting in a one-grade reduction in lint classification quality. A second problem, identified during processing, was buildup of foreign material on the drafting rolls of a drawing frame and the roving frame.

All other processing and quality characteristics were unaffected, or the change was of doubtful importance, by the presence of field-applied oil at concentrations up to 0.4 percent.

The addition of field-applied oils on seed cotton for the repression of respirable dust in processing, as characterized by this test, would not be a practical solution to the cotton dust problem.

APPENDIX

Table 1.—*Application of textile oil*

Spinning lot No.	Bale and gin lot No.	Field applied textile oil to seed cotton	Textile oil content in lint percent							
			Wagon[1]	Feeder[1]	C1[2]	LS[2]	Raw stock[3] (Shafter)[4] At harvest	Raw stock[3] (Shafter)[4] At spinning	Raw stock (Clemson)	Finished drawing sliver (Clemson)
		Percent								
1	0883-6	0.28	0.02	0.15	0.11	0.08	0.31	0.15	0.19	0.21
2	0878-1	0.								
3	0881-4	.20	.03	.10	.04	.10	.17	.10	.12	.10
4	0886-9	.43	.18	.21	.28	.21	.48	.25	.37	.35
5	0884-7	.25	.08	.30	.15	.12	.34	.17	.18	.20
6	0889-12	.51	.11	.40	.32	.26	.92	.33	.40	.40
7	0888-11	.41	.28	.21	.25	.24	.56	.37	.41	.38
8	0885-8	.41	.20	.17	.25	.16	.44	.27	.35	.36
9	0882-5	.30	.18	.21	.11	.09	.30	.17	.19	.21
10	0879-2	0.								
11	0887-10	.40	.13	.16	.29	.14	.56	.25	.33	.34
12	0880-13	.19	.06	.01	.06	.05	.11	.11	.12	.15

[1]Seed cotton samples ginned at Mesilla Park, N. Mex., and tested at Clemson, S.C. Results were variable and should be used only to illustrate variability of application.

[2]C1 is raw stock taken at the first lint cleaner condenser; LS is raw stock taken at the lint slide.

[3]Seed cotton samples taken at harvest, ginned on a miniature saw gin, and blended and divided into 2 lots. The first half was processed immediately at Shafter, Calif. The second half was processed at time of spinning at Clemson.

[4]Samples taken from bales as they were opened for processing at the Cotton Quality Research Station, Clemson.

Table 2.—*Correlation of textile oil content at various stages during test period*[1]

Stages	Lint samples from gin Wagon[2]	Lint samples from gin Feeder[2]	Lint samples from gin Cl[3]	Lint samples from gin LS[3]	Lint samples from field At harvest[4]	Lint samples from field At spinning[4]	Lint from[5] bale at spinning	Finished drawing sliver
Applied to seed cotton (calculated)	0.75**	0.80**	0.95**	0.93**	0.93**	0.95**	0.97**	0.98**
Lint samples from gin:								
Wagon		.50	.73**	.75**	.61*	.84**	.82**	.80**
Feeder			.76**	.82**	.87**	.77**	.74**	.75**
Cl				.91**	.94**	.93**	.97**	.97**
LS					.93**	.95**	.95**	.93**
Lint samples from field:								
At harvest						.92**	.92**	.92**
At spinning							.98**	.98**
Lint from bale at spinning								.99**

[1]Significance of correlation coefficient (R) is indicated by asterisks: * = 5 percent, ** = 1 percent.

[2]Seed cotton samples ginned at Mesilla Park, N.Mex., and tested at Clemson, S.C.

[3]Cl is lint sample taken at the first lint cleaner condenser. LS is lint sample taken at the lint slide.

[4]Seed cotton samples taken at time of harvest, ginned at Shafter, Calif., on miniature saw gin and blended. Subsamples tested at time of harvest and at time of spinning.

[5]Lint sample from bale at time of opening.

Table 3.—*Influence of field-applied textile oil on dust levels in gin and cardroom*

Measurement	Average values ($\bar{X}$) All lots	No oil	With oil	Correlation coefficient (R)[1] Calculated	Significance[3]	Regression coefficient (b_1)[2 3] Calculated	Significance	95-percent confidence interval[4]
	----------$\mu g/m^3$----------					$\mu g/m^3/0.1\%$		$\mu g/m^3/0.1\%$
Vertical elutriator:								
Gin area 1	406	350	418	0.211	NS	27.8	NS	--
Gin area 3	417	690	363	- .511	10%	-88.3	10%	--
Cardroom	2087	2395	2026	.701	5%	-175.1	5%	-49.6, -300.5
7.4 area sampler:								
Gin area 1	772	460	835	.376	NS	113.6	NS	--
Gin area 3	843	460	920	.266	NS	109.6	NS	--
1.5 area sampler:								
Gin area 1	748	810	736	.003	NS	.7	NS	--
Gin area 3	952	1030	565	- .018	NS	-11.2	NS	--
Personal sampler:								
Gin	1252	775	1348	.465	NS	172.7	NS	--
Cardroom	2598	2955	2527	- .755	1%	-219.7	1%	-85.4, -354.0
High volume sampler:								
Gin area 1	890	815	906	.141	NS	31.2	NS	--
Gin area 3	803	580	848	.220	NS	70.9	NS	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.

[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.

[3]NS, not significant; dashes indicate significance is less than 5 percent.

[4]With a confidence limit of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an effect on the measurement between the 2 values.

Table 4.—*Correlation of dust instrumentation*[1]

	Vertical elutriator (gin)	1.5 area sampler (gin)	7.4 area sampler (gin)	High-volume sampler (gin)	Personal sampler (gin)
1.5 area sampler (gin)	0.80				
7.5 area sampler (gin)	.71*	0.87**			
High-volume sampler (gin)	.78**	.93**	0.90**		
Personal sampler[2] (gin)	.91**	.77**	.87**	0.90**	
	.52	.82	.85**	.90**	
Vertical elutriator[3]	- .47	- .24	- .42	- .36	-0.63*
cardroom	.24	.22	.23	.37	

[1]Significance of correlation coefficient (R) is indicated by asterisks: * = 5 percent, ** = 1 percent.

[2]Personal sampler worn by ginner. Upper value is correlation with gin area 1 and lower value with gin area 3.

[3]Upper value is correlation with gin area 1 and lower value with gin area 3.

Table 5.—*Influence of field-applied textile oil on cotton moisture and trash*

Measurement	Average values ($\overline{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2,3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
	---------*Percent*---------							
Seed cotton moisture, wet basis:								
Wagon	11.03	10.60	11.12	0.424	NS	0.552	NS	--
Gin feeder	10.32	10.29	10.33	.503	10%	.146	10%	--
Lint moisture, wet basis:								
1st lint cleaner	7.97	7.82	8.01	.304	NS	.126	NS	--
Lint slide	6.86	6.59	6.91	.335	NS	.178	NS	--
Seed cotton hulls:								
Wagon	.69	.60	.69	.228	NS	.059	NS	--
Gin feeder	.20	.34	.18	- .180	NS	- .018	NS	--
Sticks:								
Wagon	.73	.66	.74	.116	NS	.013	NS	--
Feeder	.45	.38	.38	.137	NS	.015	NS	--
Motes:								
Wagon	.89	1.	.87	- .495	NS	- .031	NS	--
Gin feeder	.68	.71	.68	.135	NS	.009	NS	--
Fine trash:								
Wagon	5.02	4.14	5.19	.600	5%	.350	5%	0.678, 0.022
Gin feeder	1.80	1.73	1.82	.533	10%	- .097	10%	--
Total trash:								
Wagon	7.33	6.49	7.49	.616	5%	.391	5%	0.742, 0.039
Gin feeder	3.14	3.15	3.13	.315	NS	.103	NS	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.
[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.
[3]NS, not significant; dashes indicate significance is less than 5 percent.
[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.

Table 6.—*Influence of field-applied textile oil on fiber quality*

Measurement	Average values ($\overline{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2,3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
Fiber strength "0" gage (1,000 psi):								
1st lint cleaner	87.9	88.8	87.8	-0.248	NS	-0.528	NS	--
Lint slide	86.5	87.5	86.3	- .139	NS	- .177	NS	--
Bale	86.3	87.5	86.1	- .306	NS	- .421	NS	--
Drawing sliver	82.2	83.0	82.0	- .025	NS	- .049	NS	--

See footnotes at end of table.

Table 6.—*Influence of field-applied textile oil on fiber quality*—Continued

Measurement	Average values ($\overline{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2 3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
Fiber strength—Continued								
1/8 gage (1,000 psi):								
Bale	25.1	24.5	25.2	+ .471	NS	+ .221	NS	--
Drawing sliver	24.8	24.5	24.8	+ .564	10%	+ .193	10%	--
Fiber fineness (Micronaire):								
1st lint cleaner	4.10	4.15	4.09	- .465	NS	- .042	NS	--
Lint slide	4.07	4.18	4.05	- .702	5%	- .064	5%	-0.018, -0.110
Bale	4.08	4.10	4.07	- .491	NS	- .036	NS	--
Drawing sliver	4.04	4.15	4.02	- .570	10%	- .046	10%	--
Fiber length (inches):								
1st lint cleaner	1.144	1.134	1.146	+ .501	10%	+ .0057	10%	--
Lint slide	1.133	1.128	1.134	+ .184	NS	+ .0017	NS	--
Bale	1.128	1.120	1.130	+ .503	10%	+ .0054	10%	--
Drawing sliver	1.175	1.165	1.178	+ .461	NS	+ .0055	NS	--
Fiber length uniformity (percent):								
Bale	46.08	45.50	46.20	+ .611	5%	+ .220	5%	-0.420, 0.019
Drawing sliver	50.33	50.00	50.40	+ .195	NS	+ .146	NS	--
Neps:								
1st lint cleaner	8.9	7.8	9.2	+ .265	NS	+ .408	NS	--
Lint slide	19.3	19.8	19.3	+ .352	NS	+ .772	NS	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.

[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.

[3]NS, not significant; dashes indicate significance is less than 5 percent.

[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.

Table 7.—*Influence of field-applied textile oil on lint trash and grade*

Measurement	Average values ($\overline{X}$) All lots	No oil	With oil	Correlation coefficient (R)[1] Calculated	Significance	Regression coefficient (b_1)[2 3] Calculated	Significance	95-percent confidence interval[4]
Lint trash (percent) (Shirley) Analyzer:								
1st lint cleaner	8.94	8.58	9.01	+0.386	NS	0.258	NS	--
Lint slide	4.45	4.08	4.53	+ .579	5%	.394	5%	0.785, 0.003
Bale	4.13	3.79	4.19	+ .478	NS	.202	NS	--
Lint classification color (index):								
1st lint cleaner	83.5	85.0	83.2	- .490	NS	-1.19	NS	--
Lint slide	89.2	94.0	88.2	- .661	5%	-2.17	5%	-0.43, -3.91
Leaf trash (index):								
1st lint cleaner	73.0	73.0	73.0	- .207	NS	- .45	NS	--
Lint slide	84.3	85.0	84.1	- .385	NS	- .70	NS	--
Composite grade (index):								
1st lint cleaner	76.7	78.5	76.3	- .264	NS	- .68	NS	--
Lint slide	82.2	90.0	80.6	- .778	1%	-2.64	1%	-1.14, -4.14

[1]Measurement correlated with percent oil content of drawing sliver for each sample.
[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.
[3]NS, not significant; dashes indicate significance is less than 5 percent.
[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.

Table 8.—*Influence of field-applied textile oil on lint color*

Measurement	Average values ($\overline{X}$) All lots	No oil	With oil	Correlation coefficient (R)[1] Calculated	Significance[3]	Regression coefficient (b_1)[2 3] Calculated	Significance	95-percent confidence interval[4]
Lint reflectance (uncleaned) R_d:								
1st lint cleaner	63.8	67.2	63.1	-0.805	1%	-1.32	1%	-0.63, -2.00
Lint slide	67.3	70.8	66.6	- .793	1%	-1.53	1%	-0.70, -2.36
Bale	68.0	71.5	67.3	- .910	1%	-1.38	1%	-0.94, -1.82
Lint yellowness (uncleaned) $+b$:								
1st lint cleaner	7.95	7.85	7.98	+ .042	NS	+ .006	NS	--
Lint slide	8.66	8.55	8.69	+ .254	NS	+ .024	NS	--
Bale	8.45	8.40	8.46	- .426	NS	- .047	NS	--
Lint reflectance (cleaned) R_d:								
1st lint cleaner	72.0	74.1	71.6	- .939	1%	- .93	1%	-0.69, -1.18
Lint slide	72.5	74.2	72.2	- .877	1%	- .98	1%	-0.60, -1.36
Bale	72.3	74.5	71.9	- .921	1%	-1.02	1%	-0.72, -1.13

See footnotes at end of table.

Table 8.—*Influence of field-applied textile oil on lint color*—Continued

Measurement	Average values ($\bar{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2,3]		
	All lots	No oil	With oil	Calculated	Significance[3]	Calculated	Significance	95-percent confidence interval[4]
Lint yellowness (cleaned) +*b*:								
1st lint cleaner	9.05	9.15	9.03	+ .182	NS	+ .024	NS	--
Lint slide	9.36	9.35	9.37	+ .167	NS	+ .013	NS	--
Bale	9.18	9.05	9.20	+ .201	NS	+ .026	NS	--
Ash (inorganic matter) percent:								
Bale	2.13	2.20	2.11	+ .193	NS	+ .014	NS	--
After cleaning	1.59	1.59	1.59	+ .270	NS	+ .012	NS	--
Drawing sliver	1.68	1.68	1.68	+ .038	NS	+ .001	NS	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.
[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.
[3]NS, not significant; dashes indicate significance is less than 5 percent.
[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.

Table 9.—*Influence of field-applied textile oil on fiber distribution (Suter-Webb Array)*

Measurement	Average values ($\bar{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2,3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
Ginned lint:								
Upper quartile length (inches)	1.256	1.265	1.255	-0.171	NS	-0.0020	NS	--
Mean length (inches)	1.039	1.035	1.040	+ .347	NS	+ .0041	NS	--
Coefficient of variability (percent)	30.1	30.5	30.0	- .441	NS	- .277	NS	--
Fibers <½ inch (percent)	8.9	9.5	8.8	- .493	NS	- .273	NS	--
Fibers ½ to 1 inch (percent)	23.4	25.1	23.1	- .246	NS	- .506	NS	--
Fibers <1 inch (percent)	67.2	65.3	67.6	+ .308	NS	+7.23	NS	--
Drawing sliver:								
Upper quartile length (inches)	1.254	1.235	1.258	+ .465	NS	+ .0071	NS	--
Mean length (inches)	1.035	1.035	1.036	+ .128	NS	+ .0019	NS	--
Coefficient of variability (percent)	29.8	28.5	30.0	+ .656	5%	+ .397	5%	0.718, 0.076

See footnotes at end of table.

Table 9.—*Influence of field-applied textile oil on fiber distribution (Suter-Webb Array)*—Continued

Measurement	Average values ($\overline{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2 3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
Drawing sliver:–Continued								
Fibers <½ inch (percent)	8.9	8.0	9.1	+ .584	5%	+ .273	5%	0.540, 0.006
Fibers ½ to 1 inch (percent)	24.8	25.4	24.7	- .287	NS	- .583	NS	--
Fibers >1 inch (percent)	66.0	66.4	65.9	+ .138	NS	+ .276	NS	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.

[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.

[3]NS, not significant; dashes indicate significance is less than 5 percent.

[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.

Table 10.—*Influence of field-applied textile oil on processing and yarn quality*

Measurement	Average values ($\overline{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2,3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
Waste:								
Opening and picking (percent)	1.65	1.61	1.66	0.453	NS	+0.0590	NS	--
Card (percent)	2.94	2.96	2.82	.683	5%	+ .0655	5%	0.1148, 0.0161
Neps (No./100 in² web)	9.3	8.5	9.4	.286	NS	+ .3085	NS	--
EDMSH[5] (number)	26.3	20.5	27.5	- .094	NS	- .519	NS	--
Adjusted break factor (unit)	2,034	2,024	2,039	.124	NS	+5.808	NS	--
Yarn appearance (index)	86.9	90.5	86.2	- .319	NS	- .867	NS	--
Single strand data (Uster):								
Strength (g)	194.6	200.0	193.6	- .366	NS	-1.584	NS	--
Elongation (percent)	5.33	5.35	5.32	- .174	NS	- .040	NS	--
Strength C.V. (percent)	10.72	10.90	10.68	- .208	NS	- .087	NS	--
Neps (No./ 1,000 yd)	1,031	924	1,053	.066	NS	+4.11	NS	--
Thick places (No./ 1,000 yd)	2,558	2,621	2,546	- .653	5%	-67.8	5%	-12.3, -123.3
Low places (No./ 1,000 yd)	4,328	4,488	4,296	- .575	10%	-112.9	10%	--
Irregularity C.V. (percent)	21.24	21.35	21.22	- .527	10%	- .154	10%	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.

[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.

[3]NS, not significant; dashes indicate significance is less than 5 percent.

[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.

[5]Ends down per 1,000 spindle hours.

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Table 11.—*Influence of field-applied textile oil on open-end spinning*

Measurement	Average values ($\overline{X}$)			Correlation coefficient (R)[1]		Regression coefficient (b_1)[2,3]		
	All lots	No oil	With oil	Calculated	Significance	Calculated	Significance	95-percent confidence interval[4]
Adjusted break factor (skein)	1947	2008	1935	-0.451	NS	+14.16	NS	--
Yarn appearance	112.5	114.0	112.2	- .171	NS	- .257	NS	--
Single strand data (Uster):								
Strength (grams)	545.1	561.5	541.9	- .530	10%	- 4.554	10%	--
Elongation (percent)	5.90	6.15	5.85	- .613	5%	- .0857	5%	0.0079, -0.1643
Strength C.V. (percent)	7.92	7.65	7.97	+ .440	NS	+ .1864	NS	--
Neps (No./1,000 yd)	201	180	205	- .052	NS	- .892	NS	--
Thick places (No./1,000 yd)	207	187	210	+ .070	NS	+ 1.090	NS	--
Low places (No./1,000 yd)	1149	1124	1154	- .241	NS	-13.6	NS	--
Irregularity C.V. (percent)	14.08	14.10	14.08	- .220	NS	- .028	NS	--

[1]Measurement correlated with percent oil content of drawing sliver for each sample.

[2]Measurement considered as the independent variable with 0.1-percent oil content in drawing sliver as the dependent variable. See table 1.

[3]NS, not significant; dashes indicate significance is less than 5 percent.

[4]With a confidence level of 95 percent, an increase of 0.1 percent in oil content in the drawing sliver would have an affect on the measurement between the 2 values.